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MEMORANDUM TO: Craig G. Erlanger, Director
Division of Fuel Cycle Safety, Safeguards,
and Environmental Review
Office of Nuclear Material Safety
and Safeguards

Mark S. Lesser, Director
Division of Fuel Facility Inspection
Region II

FROM: Margie Kotzalas, Chief **/RA-APearson for/**
Programmatic Oversight
and Regional Support Branch
Division of Fuel Cycle Safety, Safeguards,
and Environmental Review
Office of Nuclear Material Safety
and Safeguards

SUBJECT: REPORT ON LESSONS-LEARNED FROM THE WESTINGHOUSE URANIUM ACCUMULATION IN SCRUBBER AND VENTILATION EVENT

On October 28, 2016, the Programmatic Oversight and Regional Support Branch issued a charter to evaluate and report on lessons learned from recent experiences at the Westinghouse Columbia Fuel Fabrication Facility. The enclosed report represents the deliverable required per the charter. Anticipated next steps are the development and implementation of an action plan to address the findings in the report.

Enclosure:
Lessons Learned Report

CONTACT: Donnie Harrison, NMSS/FCSE
301-415-247

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CONTACT: Donnie Harrison, NMSS/FCSE
301-415-2470

ADAMS Accession Number: ML16330A642 ***Via E-mail**

OFC	FCSE/PORSB	FCSE/ERB	NMSS/FCSE	FCSE/PORSB	NMSS/FCSE
NAME	ASmith	AWalker-Smith	DHarrison	**APearson for** MKotzalas	MDiaz *
DATE	11/29/2016	12/02/2016	01/03/2017	01/30/2017	01/09/2017
OFC	NMSS/FCSE	RII/DFFI	RII/DFFI	RII/DFFI	
NAME	RJohnson	OSantiago-Lopez *	EMichel *	MSykes *	
DATE	01/09/2017	01/06/2017	11/30/2016	01/23/2017	

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REPORT ON LESSONS LEARNED FROM URANIUM ACCUMATION IN SCRUBBER AND VENTILATION SYSTEMS AT WESTINGHOUSE COLUMBIA FUEL FABRICATION FACILITY

Background

On July 14, 2016, Westinghouse Electric Corporation (the licensee) notified the U.S. Nuclear Regulatory Commission (NRC) that during an annual inspection performed between May 28 and 29, 2016, to identify and remove solids in the transition section of a scrubber at the Columbia Fuel Fabrication Facility (CFFF), it identified significant amounts of uranium potentially exceeding the criticality safety evaluation (CSE) mass limit of 29 kg in the inlet transition section. As cited in Information Notice (IN) 2016-13, "Uranium Accumulation in Fuel Cycle Facility Ventilation and Scrubber Systems" (Agencywide Documents Access and Management System (ADAMS) Accession Number ML16252A171), the licensee confirmed not only significant mass several times higher than the CSE limits in the scrubber body and associated ductwork, but also significant concentrations of uranium, ranging from 34 to 55 weight percent. On August 1, 2016, the NRC dispatched an Augmented Inspection Team (AIT) to the CFFF.

Although the accumulation of material did not result in a criticality, this event still represented a criticality safety concern because the areas of accumulation had no physical controls or measures to protect against a criticality beyond the CSE mass limits that were exceeded. On August 11, 2016, the agency issued confirmatory action letter (CAL) EA-16-173 (ADAMS Accession Number ML16224B082) to the licensee, confirming the licensee's commitments to complete a root cause analysis, retain a nuclear criticality safety expert, assess the extent of condition, and evaluate safety culture, decision making, adequacy of controls, and procedures. The agency performed additional inspections of the facility prior to granting the licensee permission to restart conversion area equipment and the S-1030 scrubber. To share relevant details of the event and inform licensees about the potential for this type of uranium accumulation, as mentioned above, the NRC issued IN 2016-13.

While the facility conditions and the licensee's initial responses to the conditions found during the licensee's annual inspection of the scrubber indicate a breakdown in their processes and programs, including critical thinking and conservative decision-making, the agency's overall response to the event was appropriate and as expected. Although the agency recognizes that safe operation of a fuel cycle facility is the responsibility of the licensee, as part of the agency's platform of continuous improvement, a lessons-learned activity was initiated for this event to explore opportunities for improving agency regulatory processes in identifying facility operational issues and preventing such events in the future. On October 28, 2016, the Programmatic Oversight and Regional Support Branch (PORSB), Division of Fuel Cycle Safety, Safeguards, and Environmental Review (FCSE), Office of Nuclear Material Safety and Safeguards (NMSS) established a lessons-learned team to develop and deliver a report to FCSE and the Division of Fuel Facility Inspection (DFFI), Region II. The lessons-learned team evaluated five areas: the licensing process, inspection program, operating experience (OpE) program, roles and responsibilities, and knowledge management (KM).

During the evaluation, the lessons-learned team reviewed documents related to the license review process, the inspection program, OpE, and associated roles and responsibilities. The specific documents are cited in the "References" of this report. The team considered knowledge management within the context of these documents in terms of mechanisms to gather, develop, apply, transfer, and maintain knowledge in FCSE and DFFI. Through this review, the team gained a general understanding of the policy and procedures associated with the five evaluation areas. That knowledge combined with feedback from interviews of various NRC staff and management was used to identify potential gaps between documented policy and practice. The team used those identified gaps to make observations and recommendations as discussed in the following sections.

The team conducted group and individual interviews of staff and managers from FCSE and DFFI and Region II senior management. Specifically, the team interviewed the Westinghouse project manager (PM); several staff members from FCSE/PORSB and Fuel Manufacturing Branch (FMB); several fuel cycle facility inspectors and project inspectors from DFFI Projects Branch 1, Projects Branch 2, and Safety Branch; the augmented inspection team (AIT), with the exception of one member of the team who was unavailable at the times of the regional interviews; branch chiefs of FCSE/PORSB and FCSE/FMB; the DFFI Safety Branch, Projects Branch 1, and Projects Branch 2 branch chiefs; FCSE and DFFI division directors; and the Region II Administrator and Deputy Administrator.

The team also gathered feedback regarding day-to-day work processes. The focus of this report, however, is on lessons learned specific to the event. The following sections summarize general observations and specific observations and recommendations associated with each evaluation area. The lessons learned and feedback received related to day-to-day work processes, and associated potential improvements, will be documented in a separate report.

General observations

Based on the documentation reviewed and the feedback from NRC staff and management, the lessons-learned team has the following general observations:

1) The scope of the lessons-learned charter was appropriate to comprehensively explore opportunities for improvement. There was no need to consider new evaluation areas.

2) The team identified potential opportunities for improvement in all evaluation areas. Most identified opportunities for improvement encompass multiple evaluation areas and it is expected that any actions taken to address these opportunities will likely also impact multiple areas.

Regarding the actual event at CFFF, as discussed in the AIT inspection report, the licensee demonstrated weaknesses in critical thinking, including a questioning attitude and conservative decision-making. In addition, it is recognized that facilities without a resident inspector and limited on-site inspections create a unique challenge for inspectors to discover potential adverse conditions prior to an event. In this regard, staff, as well as management, needs to continue to

have, and reinforce having, a questioning attitude and good communication in all areas (i.e., licensing, inspection, event response, etc.). The following discussions of each of the five specific review areas emphasize improvements that could support early identification of potential adverse facility conditions or operations.

The license review process

Common themes related to the license review process are generally grounded in reinforcing some current practices while providing new or enhanced tools and guidance to develop consistent, technically sound reviews and licenses that also support inspection activities. Based on the information collected, improvement of some aspects of the license review process could result in more effective identification and resolution of weaknesses in licensee assumptions and technical bases, while also identifying areas for more focused inspections to verify these assumptions and bases.

Although Chapter 3 of NUREG-1520, "Standard Review Plan for Fuel Cycle Facilities License Applications," emphasizes use of a vertical slice review of the Integrated Safety Analyses (ISAs) summaries and licensee processes to make a finding that the licensee's safety program "provides reasonable assurance that compliance will be achieved," the license review process is currently primarily focused on a programmatic review based upon a horizontal slice of a facility's programs. This focus has resulted in limited staff review of the technical rigor of the licensee's analyses and implementation of its programs, including its ISA program. Furthermore, these reviews may not have had the benefit of full collaboration with technical experts in FCSE or inspection staff in DFFI. As licensees continue to submit longer term license renewal applications, thorough vertical slice reviews will be critical.

NUREG 1520 further provides an example of where additional guidance should be considered. Section A.9 of the appendix to Chapter 3 states that systems with IROFS that have an unmitigated risk index of 6 or 9 should be reviewed more closely than systems with IROFS established to prevent or mitigate accident sequences of low risk. However, the scrubber and ventilation system was considered to be low risk based on an assumption that accumulation of significant concentrations of uranium was highly unlikely. Based on this assumption, the accident sequences associated with the scrubber and ventilation system at CFFF were considered low risk, and thus, given less attention than other process systems. There is no further guidance on:

- How to determine the risk significance of a system for facilities that do not use a quantitative risk index method,

- The level of review low risk systems should receive, especially those systems in which the basis for the determination relies heavily on an assumption, or

- Qualifications on the "low risk" criterion, such as accident sequences with low frequency and intermediate or high consequence, should still be reviewed to examine underlying assumptions or technical justification for the associated frequencies.

As the guidance currently stands, reviewers may not be optimally examining the adequacy of licensee programs to manage presumably low risk systems, and therefore, the staff may not be taking advantage of potential insights for inspections to verify these systems are low risk.

The license review process, including activities related to new licenses, license renewal, and license amendments, should be further evaluated for improvements, such as:

- Revision to NUREG-1520, and/or development of additional staff guidance to clarify review guidance on examining the technical justification for accident sequences designated as low risk. It is recognized that the staff requirements memorandum, SRM-SECY-12-0091, "Completeness and Quality of Integrated Safety Analyses," (ML12284A033) restricts the staff's ability to revise some aspects of NUREG-1520 until an American Nuclear Society (ANS) Standard on the performance of ISA is issued. Furthermore, because the ANS Standard is expected to cover these issues, the staff terminated efforts to develop interim staff guidance (ISG) on specific ISA implementation issues per COMSECY-13-0029, "Tasking to Develop Interim Staff Guidance for Integrated Safety Analysis Implementation Issues," (ML13281A234). However, the ANS Standard still has not been issued, but is currently under development.

The inspection program

Common themes associated with the inspection program align with those of the license review process in terms of reinforcing current practices along with providing additional guidance and implementing new strategies. Based on the information collected, improvement of some aspects of the inspection program could result in earlier identification of weaknesses in facility operations and programs, while also improving the effectiveness and focus of inspections by building off the insights and input from the other evaluated areas (i.e., license review process, OpE, roles and responsibilities, and knowledge management).

Similar to the license review process, the current inspection focus is on perceived high risk accident sequences and their associated systems in an effort to implement a risk-informed approach, recognizing limited resources and limited on-site inspection time. However, the licensee considered the scrubber and ventilation system to be low risk based on the assumptions that only minor amounts of uranium powder were expected to accumulate in the transition and scrubber vessel packing; that low uranium concentration would be present within the scrubber vessel; that minimal amounts of small uranium particles were entrained within the intake ductwork; and that the scrubber constantly diluted the uranium concentration with the addition of makeup water during normal operation and anticipated upsets. The licensee used these assumptions to develop the accident sequences and establish items relied on for safety (IROFS).

Because the licensee's configuration management program did not ensure that design and physical changes to the scrubber and IROFS were properly designed and implemented to prevent adverse impact to the scrubber safety basis, material accumulated that reduced scrubber efficiency by increasing the amount of uranium carryover to the system and generating insoluble uranium bearing compounds. Complex chemical interactions from various input

streams created ammonium uranyl fluoride which is mostly insoluble in water and plated out on surfaces.

Furthermore, scrubber visual inspections did not effectively detect and remove significantly concentrated uranium from the scrubber transition, vessel, and packing areas. These deficiencies resulted in exceeding of the established mass limit. Although the licensee conducted periodic inspections of the ductwork and was detecting material accumulation, the licensee did not effectively use procedures to weigh and sample the uranium concentration in the material collected, undermining the licensee's ability to properly evaluate scrubber performance. Thus, over time, the assumptions in the licensee's safety basis became invalid. However, because the licensee designated the accident sequences associated with the scrubber and ventilation system as low risk, inspectors did not consider them for inspection sampling.

Several inspectors interviewed noted that had the scrubber and ventilation systems been part of an inspection sample, licensee deficiencies in performing criticality evaluations and implementing associated management measures would likely have been identified. Various inspection procedures appear to recognize that inspectors should examine presumably low risk accident sequences, but offer limited guidance on selecting low risk samples. As implied in the discussion of the license review process, inspection of low risk accident sequences verifies the underlying assumptions credited to designate a sequence as low risk and furthers the inspector's overall knowledge of facility operations. In the absence of resident inspectors at all sites, one challenge for fuel cycle facility inspectors is to gain a good understanding of facility operations to facilitate selection of an appropriate breadth and depth of inspection samples. Furthermore, an enhanced knowledge of a range of systems and their associated accident sequences (from low to high risk) prepares the inspector to perform more effective and targeted inspections.

Including more low risk sequences in inspection samples while fostering enhanced day-to-day knowledge of facility operations may involve changing the scope of inspections with the goal of inspecting all systems of some risk significance over a period of time. Methods to implement these changes may involve unannounced or short-notice site visits or allocating "undesignated/open" inspection time within current planned inspections (e.g., half of one day onsite) to allow (and expect) inspectors to "follow their nose" (i.e., rely on their training, observations, and instincts) to observe facility evolutions (e.g., follow ongoing facility modifications, maintenance, or testing). Project inspectors could initiate the latter method then use information gained to collaborate with fuel cycle facility inspectors during inspection planning.

Given that the AIT report highlights deficiencies in licensee safety culture, modifying the inspection scope may also mean including safety culture as an inspection element in most inspection procedures or developing a separate inspection procedure. At present, safety culture is part of Inspection Procedure (IP) 88161, "Corrective Action Program (CAP) Implementation at Fuel Cycle Facilities" which is implemented only for licensees seeking or having already obtained NRC approval of their CAP. Other procedures that may benefit from revision in scope

and guidance are IP 88025, “Maintenance and Surveillance of Safety Controls,” and IP 88071, “Configuration Management Program.”

The inspection scope could be further informed via reviews of Title 10 of the *Code of Federal Regulations*, (10 CFR) Part 70.72, “Facility Changes and Change Process,” and ISA annual submittals. At present, these examinations are meant to support inspection planning and primarily focus on high risk systems. Similar to the license review process, there is little documented guidance on how to consider low risk systems; conduct these reviews to promote a good understanding of the changes licensees have made and the effects of those changes, determine whether the licensee appropriately evaluated changes per 10 CFR 70.72 criteria, and verify whether the ISA Summary captures the changes, as necessary.

The inspection program should be further evaluated for improvements such as:

- Revision to the inspection program to modify the scope and focus of inspections whereby facility systems and processes with the potential for intermediate or high consequences, regardless of perceived risk significance, are inspected within a specified period of time. This modification will also necessitate the tracking of inspected facility processes, systems, and areas, including those undesignated inspection items, to ensure all systems and processes with the potential for intermediate or high consequence are inspected within the specified time period;

- Revision to the inspection program to include safety culture programmatic inspections, and

- Development of additional guidance for inspectors on reviewing 10 CFR 70.72 and ISA summary updates to support inspection planning, including vertical slice inspections of ISAs.

<u>The operating experience (OpE) program</u>

Common themes associated with the OpE program involve general awareness and use of the program, access to OpE information, and improvements to the OpE database. Based on the information collected, improvement of some aspects of the OpE program could result in the identification of general or typical weaknesses in facility operations and programs (e.g., consideration of prior material accumulation issues within ventilation systems at CFFF and other facilities) that could improve the effectiveness and focus of the license reviews and inspection activities leading to earlier identification of facility issues.

Among DFFI inspectors, awareness of the OpE program ranged from no awareness to some knowledge of its existence. None of the inspectors the team interviewed knew how to access the OpE database, but all expressed significant interest in gaining access. At present, the OpE Coordinator grants read-only access on an “as-requested” basis. For those inspectors who had some awareness of the program and database, they observed that the database appears to contain only relatively recent, publically available, domestic data which may limit its usefulness. Furthermore, they were unsure if the database is capable of trending events. The FCSE staff

the team interviewed had better awareness of the OpE program, but made similar observations about the OpE database.

In addition to raising general staff awareness of the program, the OpE information should be used in support of license reviews and inspection planning. The guidance in IP 88015, "Nuclear Criticality Safety," was recently revised to include OpE in inspections, but there is no formal, structured guidance for considering OpE in other IPs. Licensing and inspection policies and procedures should be revised to include appropriate consideration of the OpE Program. These revisions should support information flow to and from the program.

The operating experience (OpE) program should be further evaluated for improvements such as:

- A framework and associated guidance for continuous information flow between the OpE program and the licensing and inspection programs. Inspection manual chapters, inspection procedures, the Licensing Review Handbook (ML081130292), NUREG-1520, the OpE Policy and Procedure (P&P), Management Directive (MD) 5.12, et al may need to be revised to support this framework;

- Enhanced access to the OpE database, such as granting access to all fuel facility inspection and license review staff without having to request access. To take full advantage of access, staff in FCSE and DFFI will need training on awareness of and input to the OpE program and its use in inspection planning in supporting the focus of inspections, and

- Inclusion of legacy and international information in the OpE database to enhance completeness.

Roles and responsibilities

Common themes associated with roles and responsibilities involve understanding expectations for cross-office involvement of the staff in all the other evaluated areas and the use of these processes in performing staff activities (e.g., DFFI staff supporting FCSE license reviews, FCSE staff supporting DFFI inspection planning and inspection activities, and both office staff input to and use of OpE and knowledge management programs). Based on the information collected, improvement of the guidance and expectations associated with roles and responsibilities could result in more effective and efficient interactions between FCSE and DFFI, e.g., better information sharing related to OpE and knowledge management related to potential for material accumulation in ventilation systems, and enhance license reviews and inspection activities such that facility issues could be identified earlier.

Recently, in SECY-16-0009, "Recommendations Resulting from the Integrated Prioritization and Re-Baselining of Agency Activities," NMSS proposed, and the Commission approved, shedding the review of annual ISA Summary updates. In turn, DFFI would conduct these reviews. The rationale for the NMSS proposal was to improve staff efficiency via removal of overlapping FCSE and DFFI efforts. However, the guidance related to what role the FCSE PM and

technical staff have in supporting the DFFI reviews has yet to be developed. To improve the effectiveness of these reviews, the expectations could be clarified to achieve consistent collaboration between FCSE and DFFI. This would specifically support collaboration of the FCSE technical experts and the facility PM with the region inspectors in developing inspection samples that take into consideration of items relied on for safety (IROFS) from the ISA Summary and 10 CFR 70.72 changes. For license reviews, especially license renewals and amendments, there is an opportunity to gain insights from the regional inspectors and their knowledge of, and experience at, the facility. However, there is not a formal process for seeking or considering this input, though, in the past, some informal input has been shared and acted upon.

Guidance and expectations related to roles and responsibilities should be further evaluated for improvement, such as:

- Development of guidance on the expectations, and associated roles and responsibilities, for inspectors and FSCE PMs and technical staff on reviewing 10 CFR Section 70.72 and ISA Summary updates to support inspection planning;

- Development of guidance on the expectations and associated roles and responsibilities for gaining inspector experiences and knowledge of facilities in the license process, especially for license renewal and license amendment applications, and

- Provide rotational opportunities between FCSE technical staff and DFFI inspectors to gain an appreciation and further understanding of the roles and responsibilities of the staff in the other organization and to enhance the relationships between the staff. This action might encourage cross-office communication at the staff level that would enhance the ability to share information and insights in both the license review and inspection programs.

Knowledge management

Common themes associated with knowledge management (KM) involve qualification and training; real-time access to information; consistent and periodic transfer of knowledge among organizations and staff members; implementation of KM activities that promote continuous improvement, and the means to develop staff. Based on the information collected, improvement of some aspects of the KM program could result in more effective and efficient license reviews and inspections (e.g., KM seminars on the potential for material accumulation in ventilation systems at CFFF and other facilities) that could provide earlier identification of facility issues.

Knowledge management is inextricably linked to all the evaluation areas. It is an element critical to performing technical evaluations of licensee submittals, selecting relevant inspection samples, administering a successful OpE program, clearly understanding respective roles and responsibilities, assessing the significance of an event, and keeping all stakeholders informed as the agency responds. Most of the recommendations in the sections above involve some aspect of knowledge management.

However, there are some fundamental knowledge management aspects to consider. The current licensing and inspection qualification programs rely heavily on documentation reviews supported with some coursework and site visits. Certain skills, however, that are important to staff success, are mostly left to the staff to pursue outside of their qualification program. These skills include critical thinking, effective communication, and conflict resolution, all of which require continuous practice and are invaluable when performing license reviews, conducting inspections, and interacting at all levels.

Based on interviews, the team noted DFFI's approach to implementing KM. Aside from a brief weekly information and status call to which FCSE staff are invited, DFFI holds periodic KM seminars of selected topics and makes KM a focus of biannual counterpart meetings. These KM activities generally focus on specific technical issues or detailed discussions of current and past events. FCSE, in response to recent Federal Employee Viewpoint Survey results, has already began taking on the task of improving KM in the division and can apply, as appropriate, activities similar to DFFI.

The KM program should be further evaluated for improvements, such as:

- Revision to the qualification programs to ensure good communication and a questioning attitude is fostered and reinforced and that the technical reviewers and inspectors have the appropriate knowledge base to challenge licensee assumptions and technical bases. Specifically, include training for PMs, technical reviewers, and inspectors in critical thinking, effective communication, and constructive conflict resolution;

- Enhanced technical reviewer and inspector guidance and training on the use of ISA Summary updates and information, developing safety evaluations in a manner that support inspections, and performing a vertical slice review;

- Implementation of continuous KM activities, such as regularly scheduled (e.g., biweekly or monthly) KM seminars and a regularly scheduled (e.g., monthly or quarterly) KM newsletter or debrief on items of interest. This action might include joint and/or separate KM activities between FCSE and DFFI;

- A periodic, systematic review of licensing and inspection programs to identify gaps and support continuous improvement, and

- Hold technical counterpart meetings where the technical staff in selected disciplines (e.g., chemical safety and nuclear criticality) meet to discuss recent inspection observations, licensing issues, improvements to guidance, etc. In addition, when the annual regional counterparts meetings are held, consider the use of video conferencing with FCSE technical staff for those portions of the meeting that relate to technical discussions and presentations on fuel cycle topics.

Recommended next steps

The recommendations above consistently involve the need to further evaluate each area. Further evaluation can identify feasible improvements that FCSE can use to develop an implementation plan. Therefore, the lessons-learned team recommends FCSE lead, with input from DFFI, the development of an action plan that includes further evaluation of the five areas followed by selection and implementation of improvements consistent with the agency's mission and budget.

References

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Inspection Manual Chapter (IMC) 1246-C01, "Training Requirements and Qualification Journal for Fuel Cycle Technical Reviewer"

IMC 1246-C02, "Training Requirements and Qualification Journal for Fuel Cycle Project Manager"

IMC 1247, "Qualification Program for Fuel Facility Inspectors in the Nuclear Material Safety and Safeguards Program Area" and its associated appendices

IMC 2600, "Fuel Cycle Facility Operational Safety and Safeguards Inspection Program" and its associated appendices

IMC 2601, "Reactive Inspection Decision Making Process for Fuel Facilities"

Inspection Procedure (IP) 88003, "Reactive Inspection for Events at Fuel Cycle Facilities Program"

IP 88015, "Nuclear Criticality Safety"

IP 88020, "Operational Safety"

IP 88025, "Maintenance and Surveillance of Safety Controls"

IP 88070, “Plant Modifications”

IP 88161, “Corrective Action Program (CAP) Implementation at Fuel Cycle Facilities”

Management Directive (MD) 5.12, “International Nuclear and Radiological Event Scale (INES) Participation”

MD 8.1, “Abnormal Occurrence Reporting Procedure”

MD 8.2, “NRC Incident Response Program”

MD 8.3, “NRC Incident Investigation Program”

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